CALIFORNIA
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COMMISSION

2004 Annual Review of the PIER Program Volume 1 – Commercial Successes and Benefits

STAFF REPORT

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Arnold Schwarzenegger, *Governor*

CALIFORNIA ENERGY COMMISSION

Gary Klein,
Project Manager

Ron Kukulka,
Acting Deputy Director
ENERGY RESEARCH AND DEVELOPMENT DIVISION

Robert L. Therkelsen
Executive Director

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Introduction

The Public Interest Energy Research (PIER) program began in 1998 to evaluate the potential benefits of R&D results that are in use in their intended markets. Evaluations are based on projected sales or applications of the results through 2007, using actual sales and application histories, if available, in the analysis. Benefits are determined based on side-by-side comparisons of the products and their likely competitors in the market. A net present value is calculated for the cash flow stream over the economic lifetimes of the products. Net present values, expressed in 2004 dollars, are based on reduced energy costs, reduced operating costs, or avoided or deferred capital expenditures, and peak capacity. A dollar value that corresponds to historical emissions market trading values for NO_x, and SO_x, and to the least cost method of sequestering CO_2 emissions, is added to the net present value of the benefits.

Other benefits, not quantified by this method, will also accrue to Californians. These benefits include increased jobs and economic activity from the manufacture of products in California, a healthier environment as a result of emissions reductions, protection of plants and animals that are being damaged or threatened by energy-related activities, and improved performance and reliability of the electricity system from products that reduce the consumption or improve the transmission and distribution of electricity.

Emerging Products and Technologies: Update on Prior Success Stories

From the inception of the PIER Program through 2003, 33 products have been placed into use in their intended markets and are expected to produce ratepayer benefits between $320 million and $822 million over their lifetimes (See Tables 1 and 2). Based on PIER program disbursements of approximately $200 million through 2003, the benefit-to-cost ratio was between 1.6 to 1 and 4.1 to 1. The range of benefits reflects uncertainties in the performance and in the sales projections for the products. As discussed in the 2003 PIER Annual Report, the PIER benefit-to-cost ratio is quite comparable to results reported by other organizations with similar mandates, such as the Gas Research Institute, the Electric Power Research Institute (EPRI), the New York State Energy Research and Development Administration and the United States Department of Energy.

Additional benefits include 5.6 gigawatt-hours of electricity and 8.8 billion cubic feet of natural gas saved; and 730 megawatts of capacity construction avoided, as well as emissions reductions of SO_x (2,000 tons), NO_x (2,700 tons) and CO_2 (1.8 million tons).

Table 1 – PIER RD&D Products Commercialized Through 2002

Residential and Commercial Buildings End-Use Energy Efficiency

- Allowable Placement of Roof/Ceiling Insulation in Nonresidential Buildings
- Berkeley Lamp
- Commercial Kitchen Ventilation
- Goettl Comfortquest Gas Heat Pump[1]
- HVAC Duct Sealing Technique for Small Commercial Buildings
- Particulate Emissions Measurement for Unhooded Restaurant Appliances
- Real-Time Energy Management and Control Systems
- Requirements for Skylight Use in Low-Rise Residential Commercial Buildings
- Revised Residential Framing Factors

Industrial/Agricultural/Water End-Use Energy Efficiency

- Cast Metal Industry Electricity Consumption Study

Renewable Energy Technologies

- NOx Control in Biomass-Fueled Boilers with Natural Gas Cofiring
- PowerGuard® Solar PV System for Flat Roofs

Environmentally-Preferred Advanced Generation

- Catalytica Xonon® Catalytic Burner

Energy-Related Environmental Research

- Low NOx FIR Burner for Gas Boiler

Energy Systems Integration

- DG Interconnect Hardware
- Improved Substation Seismic Design
- Interconnection Standards for Small Distributed Generators
- Real-Time Monitoring and Dynamic Rating System for Overhead Transmission Lines
- Required Utility Buildings Seismic Vulnerability

[1] Product sales discontinued

Table 2 – PIER RD&D Products Commercialized in 2003

Residential and Commercial Buildings End-Use Energy Efficiency

- Advanced Variable Air Volume (VAV) System Design Guide
- Bi-level Stairwell Fixture
- Cal-Arch Energy Benchmarking Tool
- Design Guidelines for Skylights with Suspended Ceilings
- Hotel Bathroom Motion Sensor Nightlight
- Small Commercial Heating, Ventilating, and Air Conditioning System Design Guide
- Two-Stage, Indirect-Direct Evaporative Cooling System (IDEC)[2]

Industrial/Agricultural/Water End-Use Energy Efficiency

- Industrial Compressed Air System Energy Use Benchmarking Methodology
- Neutral Line Filter for Harmonics Reduction
- Selective Tartrate Removal System

Renewable Energy Technologies

- California Biomass Collaborative[3]
- California Wind Energy Collaborative
- California Wind Energy Resource Mapping
- Clean Power Estimator
- Evaluation of the Utility System Capacity and Customer Demand Values of Photovoltaic Systems
- PV Mounting Approach for Flat Roofs
- Solar Power Integrated Roof Tile

Environmentally-Preferred Advanced Generation

- No new products commercialized during 2003

Energy-Related Environmental Research

- Bird Fatality Reduction Methods in the Altamont Pass Wind Resource Area[4]
- Global Climate Change Study: Impacts of Global Climate Change on California[5]

Energy Systems Integration

- CERTS Control Area and Suppliers Performance for Automated Generation Control (AGC) and Frequency Response Services System[6]
- CERTS Monitoring Applications Based on Synchronized Phasor Measurements
- CERTS Volts Amps Reactive (VAR) Voltage Management Tool[7]
- Real-Time Dynamic Rating System for Electrical Transmission Lines[8]

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[2] Product commercialization did not succeed.
[3] Commercial successes from Biomass Collaborative could not be documented in 2003-04.
[4] Agreement among parties to dispute about mitigation requirements did not reach expected agreement in 2003 that would have resulted in use of PIER R&D result. See "Strategy to Minimize Avian Mortality in Altamont Pass Wind Resource Area"
[5] Release of Water Plan Update by Dept. of Water Resources did not happen in 2003 as expected. See "Global Climate Change Influences on California Water Resource Management Policy" in list of 2004 successes.
[6] California ISO made a decision to use tool of its own in place of CERTS tool.
[7] Tool did not emerge from beta test at California ISO as expected in 2003.

PIER Products Placed Into Commercial Use In 2004

Nineteen new products emerged from the RD&D cycle in 2004 that have not yet been evaluated. An analysis of the benefits of these products will be completed and published in mid-2005.

Residential and Commercial Buildings End-Use Energy Efficiency

Integrated Classroom Lighting System (ICLS).
PIER's manufacturing partner, Finelite, Inc., coats their direct-indirect fixtures with an innovative 96 percent reflective material, allowing for only two rows of fixtures instead of the traditional three rows. The Integrated Classroom Lighting System combines high quality lighting, increased flexibility, and advanced controls that sense natural light levels and room occupancy and reduce lighting levels appropriately. Nineteen demonstration classrooms have shown energy savings of 30 to 50 percent over current Title 24 levels. The system is in production and design support is available.

⇒ http://www.finelite.com

Energy Efficient Downlighting System.
Working in close partnership with Lithonia Lighting and the Sacramento Municipal Utility District, the California Lighting Technology Center developed a simple retrofit strategy for fluorescent downlights with flexible optical head mounting, two-lamp ballast, low glare reflector optics, and simplified wiring. This innovative downlighting system provides quality light, saves energy, and simplifies installation. The system, available from Lithonia, has been installed in numerous new homes and four California homebuilders are offering the systems in their homes.

⇒ http://www.lithonia.com

Hybrid Exterior Light Fixture.
The California Lighting Technology Center has also developed a series of fixtures for various exterior applications. The light emitting diode (LED) Hybrid Fixture combines cutting edge LED technology with an occupancy sensor and incandescent lighting to cut operating costs below incandescent lamps and even compact fluorescent lamps. In addition, LED-based fixtures have the capability to reduce light pollution. At the time of their founding, the sites of the present major optical astronomical observatories in California were among the best in the world. Now, however, work at all of these installations is either presently or potentially limited by the increase in the illumination of the night sky from nearby cities. Among the most common sources of light pollution are streetlights that fail to deliver all of their light downward, outdoor security lights around buildings, and billboard illumination directed upward onto the signs. One embodiment of the basic hybrid concept combines the LED and incandescent lamps into a single fixture. The incandescent source is held in a horizontal position, and the LED array is placed facing down. The construction of the fixture is such that the light output is directed down, mitigating night sky light pollution issues. This product is available from The Watt Stopper Inc.

⇒ http://www.wattstopper.com

[8] Expected sales in 2003 in California could not be documented.

Individually Addressable Ballasts.
PIER researchers worked with a National Electrical Manufacturers Association-facilitated working group of major manufacturers to develop an enhanced, open controls standard to allow for a complete Digital Addressable Lighting Interface (DALI)-managed lighting system. The enhanced DALI open standard will enable the control devices of different manufacturers to operate on the same control system. Digital ballast technology is combined with reliable low-cost communications and simple automation to produce reliable and cost-competitive fluorescent dimming that can improve energy savings, occupant satisfaction, and building operation. The final standard is expected to receive International Electrotechnical Commission approval in late 2005.

⇒ http://www.iec.ch

SpeciFlow Air Flow Measurement and Control.
The PIER program is funding a portion of the work by Federspiel Controls, LLC to develop a new airflow measurement and control technology called SpeciFlow. This new technology is a less expensive solution for measuring and controlling air flow in HVAC systems, enabling building owners to save energy and ensure that indoor air quality standards are met at all times. Greenheck Fan Corporation has licensed the technology and will have damper and louver assemblies with the technology integrated.

⇒ http://www.federspielcontrols.com/tech.htm

HVAC Duct Sealing Technique for Large Commercial Buildings.
The PIER program is working with Carrier Commercial Services and Lawrence Berkeley National Laboratory to develop an aerosol-based system called MASIS for sealing the ducts of large commercial buildings. MASIS, which stands for "mobile aerosol-sealant injection system," consists of a mobile cart, an air compressor and computer automated sealing monitoring system. This system, originally patented for sealing ducts and reducing energy loss in residential and small commercial systems, now incorporates two new patented technologies that permit multiple simultaneous aerosol injection processes in the larger, more complicated duct systems of commercial buildings. The energy savings and demand reduction should be 20-40percent of fan-system energy use and 5-10 percent of cooling energy use.

⇒ http://www.aeroseal.com/commercial_duct_sealing.html

Cool Roof Coating, Cooltile IR Coatings.
The PIER program is working with American Rooftile Coatings (ARC) and Lawrence Berkeley National Laboratory to develop coatings and processes to refinish concrete, clay, and fiber cement roof tiles that restore color to the roof and impart “cool roof” properties to it. The product, Cooltile IR Coatings, consists of an acrylic base infused with near-infrared transparent pigments. Cool roofs reflect solar heat back to the sky, save on air conditioning costs, moderate interior temperatures, and reduce the urban heat island effect. ARC offers their product in a full palette of colors.

⇒ http://www.americanrooftilecoatings.com

Industrial/Agricultural/Water End-Use Energy Efficiency

Energy-Efficient Ultra Low-NOx Gas-Fired Burner Control Technology.
The Alzeta Corporation has developed and implemented an advanced gas-fired burner emissions control technology for industrial boilers that reduces NOx emissions to nine ppm while also reducing electricity consumption for fan power. NOx emissions reduction is commonly accomplished by reducing the average burner flame temperature by either excess air input or by flue gas recirculation. Flue gas recirculation generally results in higher boiler thermal efficiency than excess air input. However, the volume of flue gas recirculated is much larger than the amount of excess air input for the same NOx reduction. Consequently, more fan power is required for flue gas recirculation, and this fan power increases with the cube of the volume. The Alzeta innovation was to develop advanced control technologies that allow the boiler to be operated with flue gas recirculation at low thermal loads and gradually shift to excess air as the load increases above about 82 percent of capacity. It is estimated that this strategy will reduce the electricity consumption for boiler fan power by about 25 percent. Further, a smaller fan will also be required, reducing the initial cost of the NOx control hardware. This advanced NOx control technology has potential for use throughout California, but especially in the San Joaquin Valley, which is a severe ozone non-attainment area. Retrofitting of existing boilers to reduce NOx emissions to nine ppm or less will be required beginning in 2005. The technology could be used in up to 1600 boilers in that area, reducing annual electricity consumption by over 65,000 MW-hrs and summer peak electric load by nearly 30 MW compared to the use of flue gas recirculation as a strategy. Savings to boiler operators is an estimated $6.5 million per year in addition to a one-time savings of about $5 million because of reduced fan size requirements.

⇒ http://www.alzeta.com/csb.htm

Programmable Logic Control (PLC) System Protection Benchmark/Workshop.
PIER funded a project with the Del Monte Foods Company to explore ways of increasing the reliability of process systems using PLC devices. The findings helped Del Monte to increase the reliability of the plant and to prevent outages at critical times during the process. The results have now been included in a workshop offered to companies by EPRI PEAC, a part of EPRI Solutions.

⇒ http://www.eprisolutions.com

Software Tool/Communications Protocol for Demand Response.
PIER has funded the development and demonstration of an open source communications protocol based on XML and an automated demand response system. The goal of the work was to develop a system requiring minimum human attention that could respond to energy price signals from a utility according to rules set up by a user, and shed load during critical peak times with minimum loss of service. Because the protocol is based on open source software, use of the protocol can be integrated with any energy management system (EMS); no proprietary EMS is required. Tests conducted by Lawrence Berkeley National Laboratory in November 2003 and again in September 2004 have shown that significant load shedding is possible through automated demand management and that the XML communications protocol and demand response system developed by the PIER Demand Response Center works as planned.

⇒ http://www.ciee.ucop.edu/dretd/Piette_02_04_2005.pdf

Energy Related Environmental Research

Strategy to Minimize Avian Mortality in the Altamont Pass Wind Resource Area.
The construction and operation of wind turbines in California has resulted in a collision of two high priority state and national goals—the protection of the environment and the promotion of renewable resources. Specifically, numerous individual birds belonging to species protected by

state and federal laws have been killed in the Altamont Pass area as a result of collisions with wind turbines, tower structures, or feeder wires for collecting turbine-generated electricity and feeding it into the electricity transmission system for distribution. Birds that have been killed include eagles, hawks, falcons, owls and other protected birds. The relevant laws that prohibit such bird kills include the Federal Bald and Golden Eagle Protection Act, Sections 2000, 3503.5, 3511, 3513, and 3800(a) of the California Fish and Game Code, and the Federal Migratory Bird Treaty Act. As a result of the kills, a dispute arose, and environmental groups subsequently sued Alameda County to require that it enforce the state and federal laws. In addition to environmental groups, wind property owners/operators, and Alameda County, the California Department of Fish and Game, the U.S. Fish and Wildlife Service, and the California Energy Commission were drawn into the dispute. PIER has funded studies identifying causes of and possible mitigation measures to reduce bird kills to levels that are acceptable to environmentalists and the state and federal governments while not imposing undue burdens on the wind industry. The wind industry has proposed a mitigation plan based on the PIER work, and this plan is to be considered at a January 7, 2005 meeting of the parties involved in the dispute. If no agreement is reached that is satisfactory to all parties, it is almost certain that no expansions of wind capacity in the Altamont Pass area will be allowed and that a gradual retirement of the wind capacity in that area might be required. A total of about 580 MW of wind capacity has been constructed to date in the Altamont area through 2002, and it has been estimated that this capacity could be increased to approximately 1200 MW if this issue is resolved.

⇒ http://www.energy.ca.gov/2005publications/CEC-500-2005-005/CEC-500-2005-005.PDF

Global Climate Change Influences on California Water Resource Management Policy.
Scientists have studied the relationships between anthropogenic emissions of carbon dioxide, methane, and other gases whose buildups in the earth's atmosphere are judged likely to cause global warming. Although the magnitude and rate of such warming is subject to a great deal of scientific uncertainty because of unknown factors with respect to global sources and sinks of these gases, scientists do appear to be reaching a consensus that global warming is occurring and will continue in the absence of significant reductions in emissions of the “greenhouse” gases (GHG). Local and regional impacts are subject to even greater uncertainty, with some regions likely to benefit and others likely to suffer. Benefits for specific regions can only be predicted with complex global climate models. Finally, there are significant uncertainties about how nations of the world will respond to the threats (or opportunities) offered by climate change. Various nations might decide to reduce greenhouse gas emissions to reduce the global warming effect, to simply adapt to future changes in the climate, or somewhere in between. No matter what the outcome of the future climate changes and governmental responses to the changes, it behooves government planners to consider the alternative outcomes and to be sure that we are prepared. PIER has been supporting studies of the range of potential impacts on California of future climate change that have been designed to provide useful information to other California state agencies. In particular, the PIER work has been used by the California Department of Water Resources (DWR) in developing its draft five-year plan. The draft plan reflects the first time that DWR has included the effects of global climate change in its planning of state water policy.

⇒ http://www.waterplan.water.ca.gov/b160/workgroups/chrwg/July21.04/Ch3_(07-21-04)_comb.pdf

GHG Reporting Protocol for Power Generation and Electric Utilities.
PIER has funded research to develop reporting protocols for the electric utility companies to use in reporting their GHG emissions to the California Climate Action Registry. This protocol provides a framework for participation in the Registry, including required principles, procedures, approach, and methodology for calculating and reporting GHG emissions to the Registry. The use

of the protocol ensures that all participants are on an equal footing and that GHG emissions are measured in a consistent way among all participants. Consistent use of the protocol will minimize transaction costs for participating in any future GHG emissions market. In addition, industry standard emissions data developed as part of the protocol development process should be useful to participants as a benchmark to compare their company's performance against that of their peers'.

⇒ http://www.climateregistry.org/PROTOCOLS/PUP/

Development of Data and Methodology for Implementation of a Carbon Sequestration Market in California Forests.

The possible future development of a market for carbon sequestration will require reliable information to monitor and verify the amount of carbon sequestered, credible methodologies for measuring the impact of measures to sequester carbon, and reliable data to determine the market price and benefits of alternative approaches to sequestration. Research funded by PIER provided a baseline documenting how carbon content in soil and vegetation in California has changed in the last 10 years and evaluated current trends in that content. An estimate of the potential for future carbon sequestration in California forests was developed, as was a monitoring and verification protocol that can be used by landowners to document the amount of carbon sequestered by future projects. The information gathered in the process of baseline development was also integrated into a supply curve for carbon sequestered versus cost. The results are being used by the California Climate Action Registry to develop a protocol that can be used for current voluntary efforts to sequester carbon in California. Effective use of the results of the studies will reduce transaction costs in any future carbon emissions market.

⇒ http://energy.ca.gov/PIER/environmental/energy_reports.html#climatechange

Bird Electrocution Mitigation Web Site and Product Encyclopedia.

PIER previously funded a project by the Pacific Gas and Electric Company (PG&E) to understand the causes of bird electrocutions from power lines and to develop mitigation measures to reduce the frequency of such electrocutions. The PG&E work showed degradation of protective measures over time and a disturbingly high percentage of improper installations of mitigation devices. PG&E had reported that the results were being used in their employee training courses, but it was apparent that a need existed to make such information on mitigation devices, installation techniques, and the advantages and disadvantages of alternative devices widely available to the electric utility industry. In order to ensure the widespread availability of this information, PIER funded the development by EDM International, Inc. of a website and a product encyclopedia to provide information on mitigation products and installation techniques for common utility structures**.** Finally, a users' forum is provided to obtain feedback from utilities on product performance and needed enhancements of the website and the encyclopedia. It is expected that use of the website will reduce utility costs to install mitigation measures, improve the performance of the measures, and increase reliability by reducing wildlife-related power outages. This website is not online at the time of this writing, but a link to EDM is given below.

⇒ http://www.edmlink.com

Study and Scenario Analysis of the Air Quality Impacts of Distributed Generation in the South Coast Air Basin.

The net air quality impacts of distributed generation (DG) are not clear. On the one hand, locating small generators near demand centers reduces electricity losses and generator fuel use and thus tends to reduce emissions. On the other hand, it is easier and cheaper to control emissions for a large central power plant, which tends to suggest that distributed generators may tend to increase emissions. PIER funded a study that included the development of a systematic method to characterize DG implementation and the simulation of air quality impacts for 30 DG

implementation scenarios in the South Coast Air Basin. Results showed that the local air quality impacts of DG could be either positive or negative, but that DG air quality impacts basin-wide in 2010 are negligible in any likely scenario, provided strict California Air Resources Board and the South Coast Air Quality Management District emissions limits are met by generators. The results of this study will help to inform future DG policy in California.

⇒ http://www.energy.ca.gov/PIER/notices/2004-09-27_seminar/2004-09-27_DABDUB.pdf

Energy Systems Integration

No new products reported for 2004.

Environmentally Preferred Advanced Generation

No new products reported for 2004.

Renewable Energy Technologies

City and County of San Francisco Wind Resource Assessment.
With funding from PIER, Itron, Inc. has assessed the potential for development of wind energy at five specific sites in the San Francisco area. Sites included in the assessment were Twin Peaks, Treasure Island, Hunter's Point, the San Francisco Zoo, and PIER 39. Hourly wind data were estimated for a "normal" year, and annual electricity production was estimated for a 10 kW horizontal axis wind turbine on a 98-foot tower. All of the sites except Twin Peaks were found to have only modest wind resources relative to typical sites that have been developed elsewhere in California. The use of this assessment by the City and County of San Francisco planners will help them to make judicious decisions about future wind development in that area.

⇒ http://www.energy.ca.gov/reports/2004-10-13_500-04-066.PDF

New California Geothermal Site Identification and Qualification.
Geothermex, Inc. has developed an estimate of the size of the total remaining geothermal resource in California and western Nevada using accepted volumetric techniques. They estimated that the likely size of the remaining resource in the entire California western-Nevada study area is 4300 MW, with about 3000 MW in California. As the study was limited to resources for which some public-domain information is available, the total estimated remaining resource is thought to be conservative. Geothermex also estimated the development costs for the remaining resource. They concluded that the average development cost for the entire study area would be about $3100 per kilowatt and, for California alone, about $2950. Based on the assumption that $2400 per kilowatt would be competitive with other renewable resources, the study concludes that approximately 1700 MW of the remaining undeveloped geothermal capacity would be competitive. The data developed in this study should benefit developers in selecting the best locations for new geothermal capacity and the state of California in optimizing the implementation of the Renewable Portfolio Standard.

⇒ http://www.energy.ca.gov/reports/500-04-051.PDF

California RPS Renewable Generation Integration Cost Analysis Methodology.
The California Wind Energy Collaborative, with support from the Oak Ridge National Laboratory, the National Renewable Energy Laboratory, the California Independent System Operator, Geothermex, Inc., and Dynamic Design Engineering, Inc. conducted a study on the integration costs of renewable electricity generating technologies. Integration costs are those indirect costs associated with ongoing utility expenses from integrating and operating eligible

renewable energy resources. Integration costs include capacity credits (value of new conventional generating capacity that is avoided as a result of installed renewable generation), regulation costs (costs of making up for short-term mismatch between supply availability and demand), and load following costs (costs of making up for long-term mismatch between supply availability and demand). The result of the integration cost analysis methodology effort is a set of procedures for performing the cost calculations, recommended sources of data for the analysis, and recommendations for use of the methodology in the Renewable Portfolio Standard bidding process. The use of this methodology will provide a transparent and consistent treatment of competing bids and will help to ensure that state payments to bidders are reasonable and justifiable.

⇒ http://www.nrel.gov/docs/fy04osti/35947.pdf

⇒ http://www.energy.ca.gov/reports/500-04-054.pdf